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Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2017/027

ASSESSMENT OF THE QUEBEC NORTH SHORE (DIVISION 4S) HERRING STOCKS IN 2016

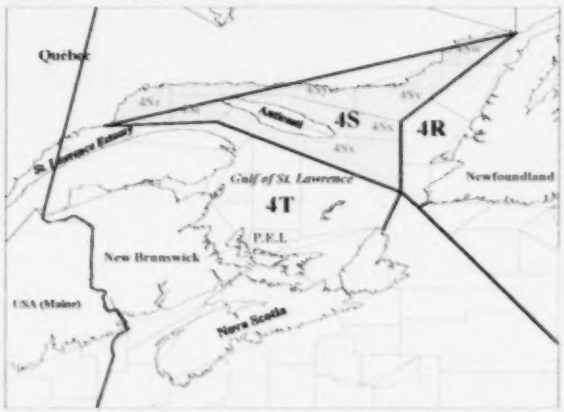

Figure 1. Map of unit areas of NAFO Division 4S (Quebec North Shore). Division 4S is defined by the coloured area.

Context:

Since 1992, the herring fishery on the Quebec North Shore (NAFO Division 4S) has been managed by a preventive Total Allowable Catch (TAC) of 4,000 t due to the lack of scientific information to establish a formal TAC. This TAC is assigned in whole to various fishing fleets and to all catches, without distinction of spawning groups. Between 1984 and 2010, herring landings were, on average, 476 t per year. Catches have increased significantly since 2011, reaching the TAC of 4,000 t.

A first series of acoustic surveys was conducted in 2009, 2010, 2011 and 2013 in the eastern part of the Lower North Shore of Quebec (unit area 4Sw). A second series of surveys that covers the entire coastal area of 4S began in 2016. Once the series is long enough, it will be possible to analytically assess the two herring spawning groups in the North Shore of Quebec, as well as establish limit reference points to define a strategic framework for the fishery based on the precautionary approach.

The last assessment of the two herring spawning stocks in Division 4S was in 2011. A stock status update was made in 2015. The Fisheries and Aquaculture Management Branch requested scientific advice on these stocks for the 2017 and 2018 fishing seasons. This science advisory report is from the April 12, 2017, meeting on the assessment of the Quebec North Shore herring stocks. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

SUMMARY

- Herring landings on the North Shore of Quebec have increased significantly since 2011, reaching the TAC of 4,000 t. In 2016, preliminary landings were 4,022 t.
- Unlike the period prior to 2011 dominated by fixed gear fishery in the western part of the area, the majority of landings are now from the purse seine fishery practised in unit area 4Sw.
- Spring and fall herring spawner catches are currently dominated by fish aged 10 years and older. No significant recruitment has been observed since 2005 in both spawning stocks.
- A first acoustic survey, which covers the entire 4S coastal area, was conducted in fall 2016. The total biomass index is estimated at 830t for spring spawners and 21,477 t for fall spawners.
- Five acoustic surveys were conducted between 2009 and 2016 in unit area 4Sw located in the eastern part of the Lower North Shore of Quebec. The stock biomass index for spring and fall spawners in unit area 4Sw has dropped significantly since 2010.
- Given the lack of significant recruitment, the older age of fish in catches and the decrease in the 4Sw biomass index, the current 4Sw catch level may lead to a local depletion of the resource. The fishing effort should be more dispersed all along the coast and less concentrated in 4Sw.
- Given the total biomass index in 4S, the TAC of 4,000 t should not be increased. If measures are not implemented to reduce fishing effort in 4Sw, the TAC should be reduced.

INTRODUCTION

Species biology

Herring (*Clupea harengus*) is a pelagic fish found in cold North Atlantic waters. Its distribution in Canada extends from the coasts of Nova Scotia to the coasts of Labrador. It travels in tight schools in order to feed, spawn near the coast, and overwinter in deeper waters. The same herring return to the same feeding, spawning, and wintering sites year after year. This homing phenomenon is attributed to a learning behaviour with the recruitment of young year-classes in a population. At spawning, eggs attach themselves to the sea floor, forming a carpet of a few centimetres thick. The egg incubation time and larval growth depend on ambient environmental characteristics such as water temperature. Most herring reach sexual maturity at 4 years, at a length of about 27 cm. The herring populations of the North Shore of Quebec are characterized by two spawner groups. Spring herring generally spawn in April and May, and fall herring in August and September.

Overview of the fishery

Since 1992, the herring fishery on the Quebec North Shore (NAFO Division 4S) has been managed by a preventive Total Allowable Catch (TAC) of 4,000 t due to the lack of scientific information to establish a formal TAC. Purse seine, traps, and gillnets are the main fishing gear used on the North Shore of Quebec. There is no TAC distribution among the different types of fishing gear, and the fishing is competitive. Herring on the North Shore is also used as fishing bait for snow crab, lobster, and groundfish fisheries.

ANALYSIS

Commercial fishing

Herring catches on Quebec's North Shore have increased significantly since 2011, reaching more than 70% of the TAC of 4,000 t (Figure 2). Average annual landings went from 476 t for the 1984–2010 period, to 3,748 t for the 2011–2016 period. In 2016, preliminary landings were 4,022 t (Table 1).

Since 1984, most herring catches on Quebec's North Shore have come from three unit areas, namely 4Sz of Division 4S WEST, and 4Sv and 4Sw of Division 4S EAST (Table 1, Figure 2). Between 1984 and 2007, 55% of catches on average were from the west area. Since 2008, more than 97% of the catches have been made in Division 4S East and are largely concentrated at the east end of unit area 4Sw, between Old Fort and Blanc-Sablon (Table 1, Figure 3).

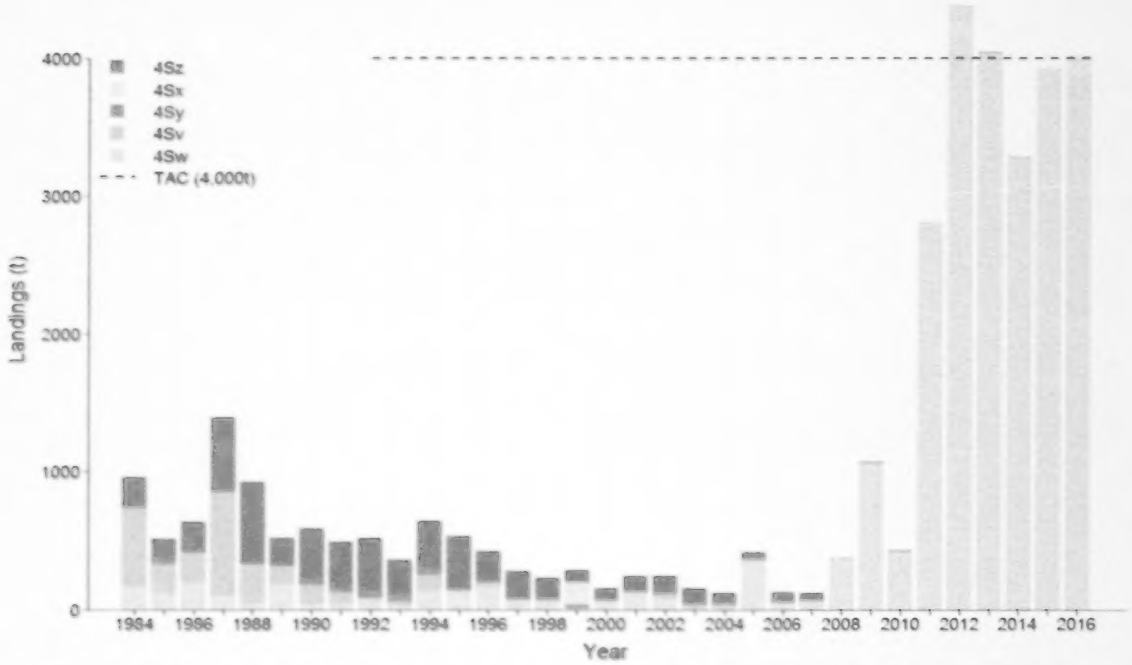

Figure 2. Herring cumulative commercial landings (tons) in the unit areas on the Quebec North Shore (NAFO Division 4S) from 1984 to 2016. Landings in 4Si and 4Ss are not presented because they have always been very low (see Table 1).

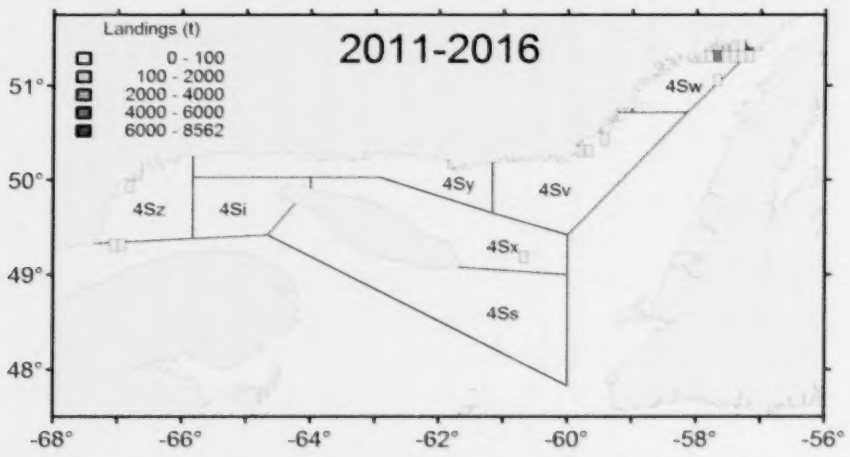

Figure 3. Spatial distribution of herring catches on Quebec's North Shore (NAFO Division 4S) for 2011 to 2016 seasons combined.

Historically, most herring landings on the North Shore of Quebec were associated with the gillnet (Figure 4). As of 2008, net traps replaced gillnets in Division 4S East only (Table 2). Since 2011, the purse seine has been used most often, with an annual average of 80% of herring catches; traps have been used in 18% of catches and gillnets in less than 2% of catches (Figure 4).

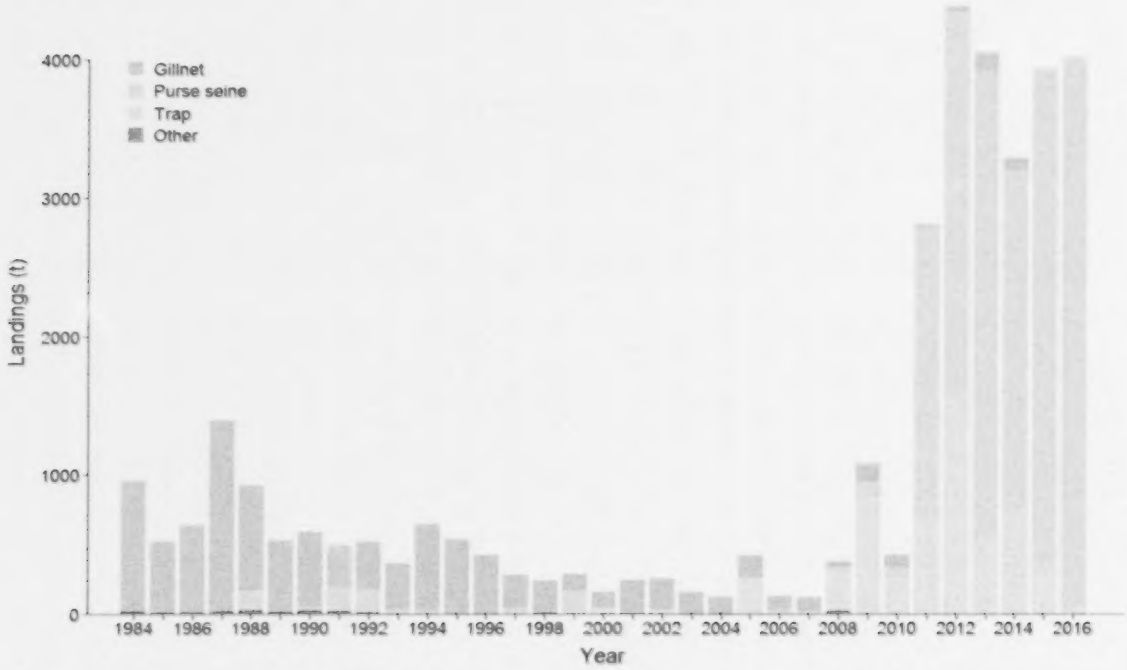

Figure 4. Herring cumulative commercial landings (tons) by fishing gear on the Quebec North Shore (NAFO Division 4S) from 1984 to 2016.

Table 1. Annual herring catches (tons) in the east and west unit areas of NAFO Division 4S from 1984 to 2016.

AREA	UNIT AREA	MEAN (1984-1999)	YEAR																MEAN (2000-2016)
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2016*	
East	4Ss	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	4Sv	162	4	10	36	27	15	12	8	17	4	24	10	5	5	8	1	2	0	11
	4Sw	99	63	124	82	16	24	351	50	53	371	1,051	415	2,799	4,378	4,038	3,284	3,932	3,884	1,466
	4Sx	10	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	137	8
	Total	**271**	**67**	**134**	**119**	**43**	**40**	**363**	**58**	**69**	**375**	**1,075**	**425**	**2,805**	**4,383**	**4,047**	**3,285**	**3,934**	**4,021**	**277**
West	4Si	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4Sy	22	0	0	1	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0
	4Sz	291	94	116	132	114	87	59	70	51	4	3	5	5	2	0	0	0	0	44
	Total	**313**	**94**	**116**	**133**	**114**	**87**	**59**	**70**	**51**	**5**	**3**	**5**	**5**	**2**	**2**	**1**	**0**	**1**	**44**
TOTAL 4S		**584**	**161**	**250**	**251**	**157**	**127**	**423**	**129**	**120**	**380**	**1,078**	**430**	**2,810**	**4,385**	**4,409**	**3,286**	**3,934**	**4,022**	**191**

* *Preliminary data*

Table 2. Annual herring catches (tons) for the main fishing gear used on Quebec's North Shore (NAFO Division 4S) from 1984 to 2016.

AREA	GEAR	MEAN (1984-1999)	YEAR																MEAN (2000-2016)
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2016*	
East	Gillnet	251	24	133	86	43	39	101	31	45	44	120	87	11	35	125	80	2	0	59
	Trap	2	43	0	32	0	0	254	5	24	307	853	259	681	1 576	561	760	369	39	339
	Purse Seine	16	0	0	0	0	0	7	22	0	4	102	79	2 112	2 771	3 361	2 445	3 563	3 981	1 085
	Other	2	0	0	1	0	1	0	0	0	20	0	0	0	0	0	0	0	0	1
	Total	**271**	**67**	**134**	**119**	**43**	**40**	**363**	**58**	**69**	**375**	**1 075**	**425**	**2 805**	**4 383**	**4 047**	**3 285**	**3 934**	**4 021**	**277**
West	Gillnet	270	87	116	133	114	87	59	70	51	5	3	5	5	2	2	1	0	0	44
	Trap	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Purse Seine	33	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**313**	**94**	**116**	**133**	**114**	**87**	**59**	**70**	**51**	**5**	**3**	**5**	**5**	**2**	**2**	**1**	**0**	**1**	**44**
TOTAL 4S		**584**	**161**	**250**	**251**	**157**	**127**	**423**	**129**	**120**	**380**	**1 078**	**430**	**2 810**	**4 385**	**4 409**	**3 286**	**3 934**	**4 022**	**1 529**

* *Preliminary data*

The herring fishery on the North Shore of Quebec usually begins in spring in unit area 4Sz (Division 4S West) and continues in the summer and early fall in 4Sv and 4Sw (Division 4S East). Timing of landings shows that since 2011, the fishery in Division 4S East has been ending earlier every year, ending as early as mid-August.

Biological indicators

Annual catch-at-age composition indicates that the two herring spawner stocks of the Quebec North Shore are characterized by the occasional occurrence of dominant year-classes. In the spring and fall spawners, the most recent year-class is that of 2005 and, to a lesser extent, that of 2008 (Figure 5). However, the year-class of 2005 (fish aged 11 years) still dominate commercial catches. In 2016, this year-class alone accounted for 28% and 40% of herring spring and fall spawner catches, respectively.

Among spring spawners, a new year-class (2013) seems to have emerged in the fishery in 2016 (Figure 5A). However, it will take several years before its scope can be assessed.

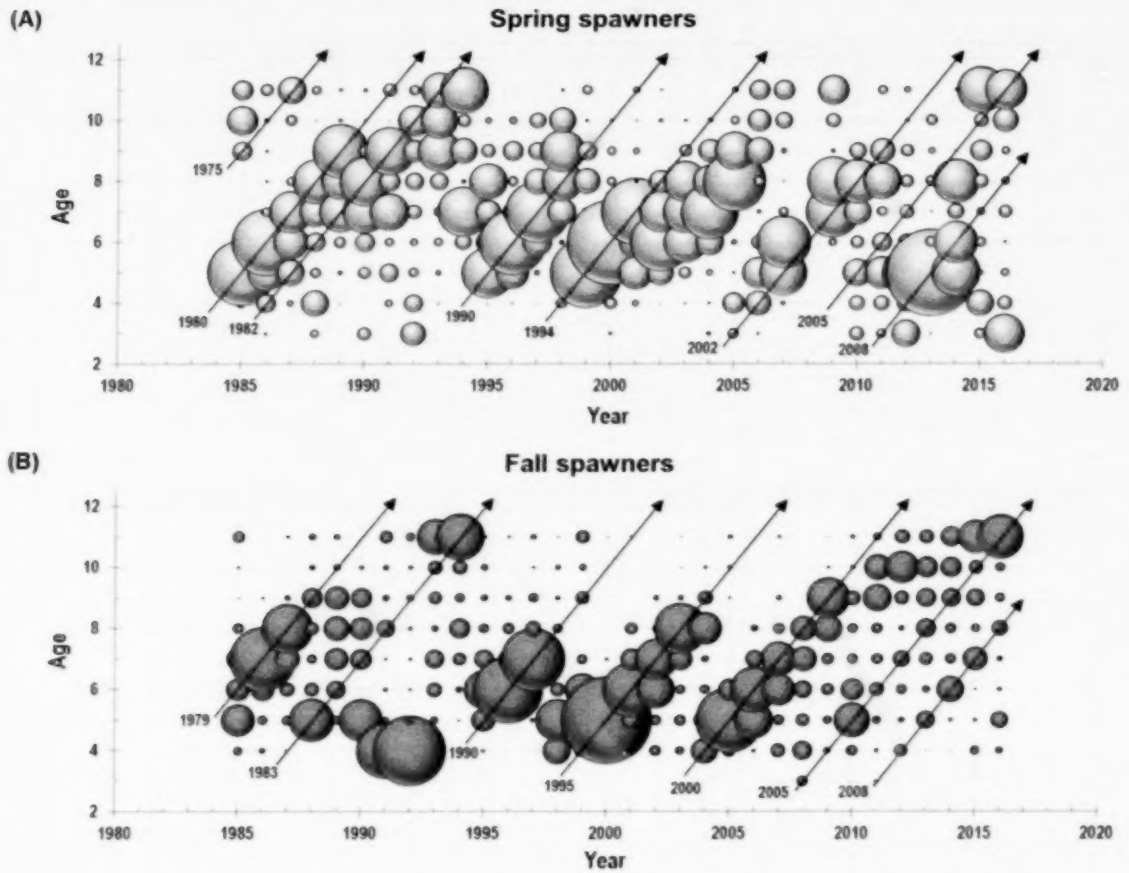

Figure 5. Annual catch-at-age composition (%) of herring, spring (A) and fall (B) spawners, on the North Shore of Quebec (NAFO Division 4S) from 1985 to 2016. The dominant year-classes are shown.

The average condition of fall-spawning herring is generally higher than that of spring-spawning herring, although the condition index has increased significantly in recent years among spring spawners (Figure 6). The condition index among spring spawners showed a significant decrease between 1984 and 1993, followed by an increase until 2016. The condition index for fall spawners has remained relatively stable since 1984.

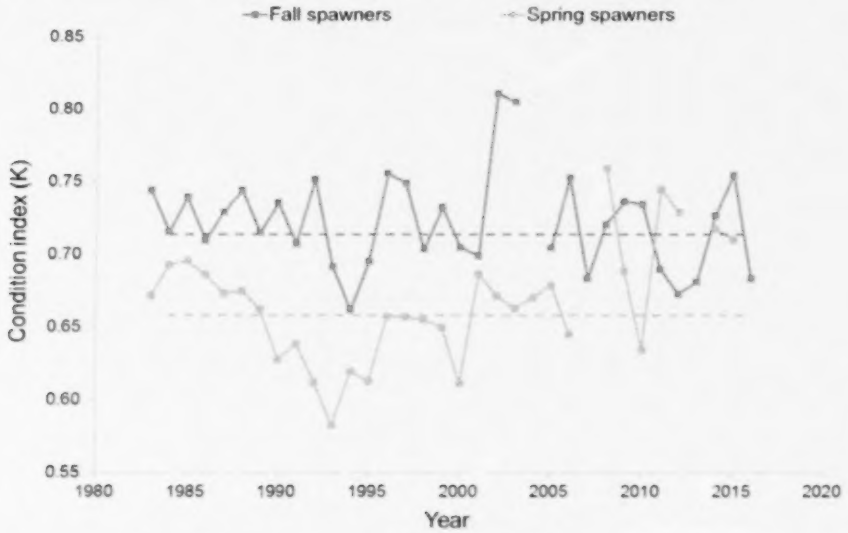

Figure 6. Average annual condition index (K) of spring (April to June) and fall (July to November) spawning herring on the Quebec North Shore (NAFO Division 4S). The horizontal lines show the 1984 to 2016 averages.

Acoustic surveys

A first acoustic survey, which covers the entire 4S coastal area, was conducted from October 30 to November 11, 2016. This survey, exploratory in nature, includes 7 strata composed of transects perpendicular to the coast (strata 1-3 and 6) and transects in zig-zag (strata 4, 5 and 7) when the area covered is wide (Figure 7). All transects were completed, except for one transect in stratum 4, and five transects in stratum 7.

The most significant acoustic signals were measured in stratum 4, especially near Havre-Saint-Pierre (Figure 7). For the entire 4S coastal area, the total biomass index is estimated at 830 t for spring spawners and 21,477 t for fall spawners.

Four acoustic surveys were also conducted between 2009 and 2013 in unit area 4Sw located in the eastern part of the Lower North Shore of Quebec (Figure 8). The area covered by these surveys corresponds to stratum 1 from the 2016 survey. The biomass index of spring spawners in unit area 4Sw plummeted between 2009 and 2016 from 1,041 t to 41 t (Figure 9). In 2009, spring herring accounted for 16% of the biomass of the two spawning stocks compared to just under 3% in 2016. The biomass index of fall-spawning herring also dropped sharply in 4Sw, from 27,087 t in 2010 to 1,518 t in 2016 (Figure 9).

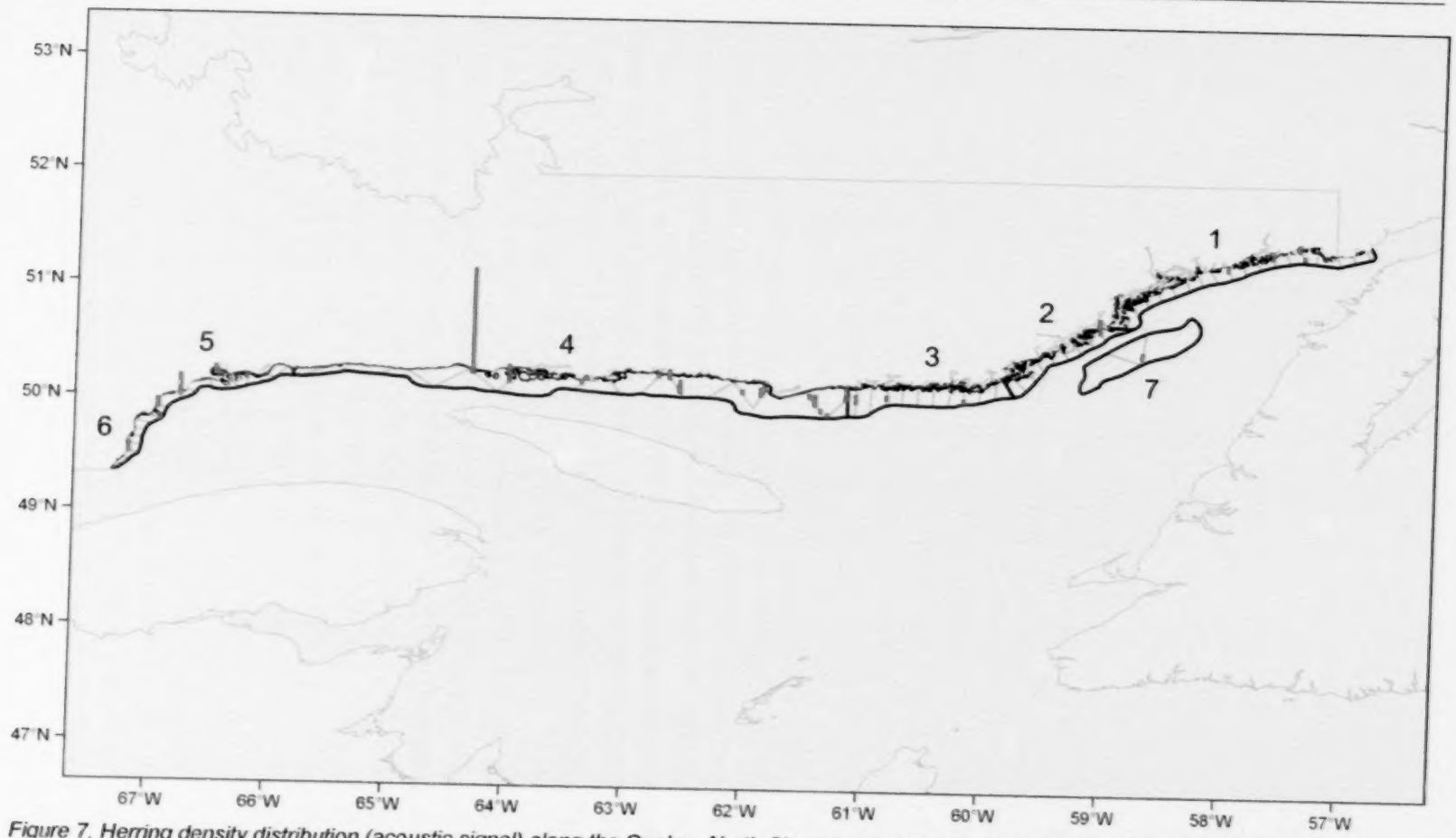

Figure 7. Herring density distribution (acoustic signal) along the Quebec North Shore in fall 2016. Strata limits (black) and completed transects (grey lines) are shown.

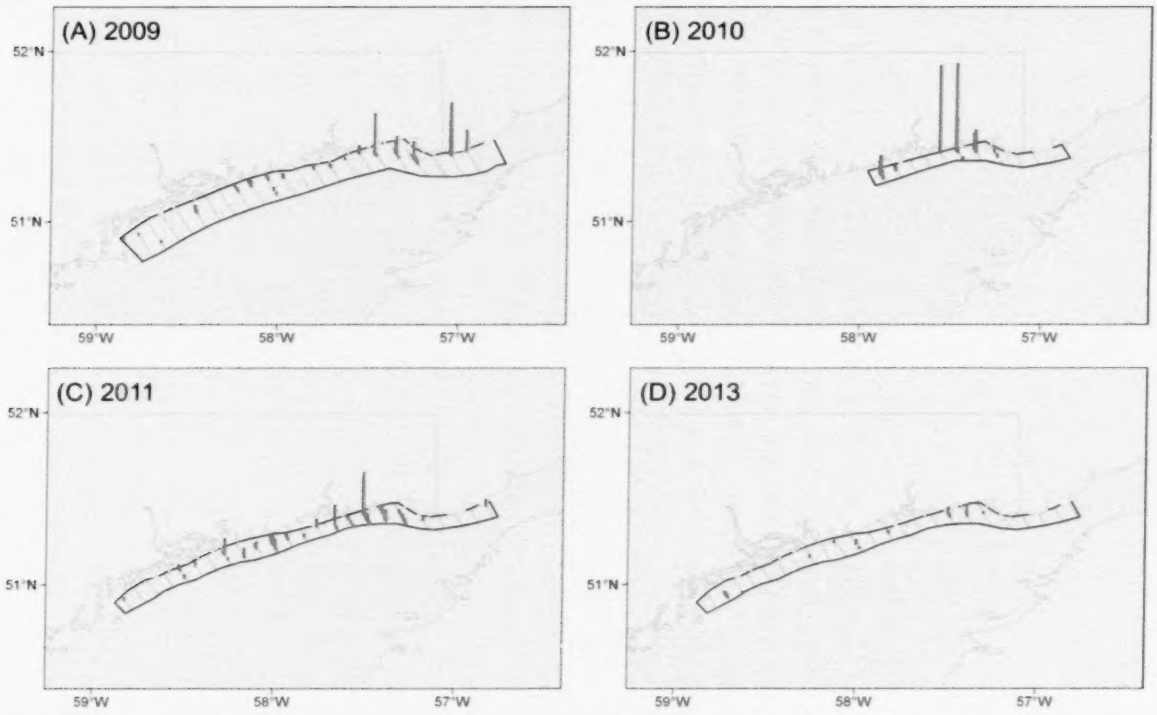

Figure 8. Herring density distribution (acoustic signal) in unit area 4Sw located in the eastern part of the Lower North Shore of Quebec, fall of 2009 (A), 2010 (B), 2011 (C) and 2013 (D). Strata limits (black) and completed transects (grey lines) are shown.

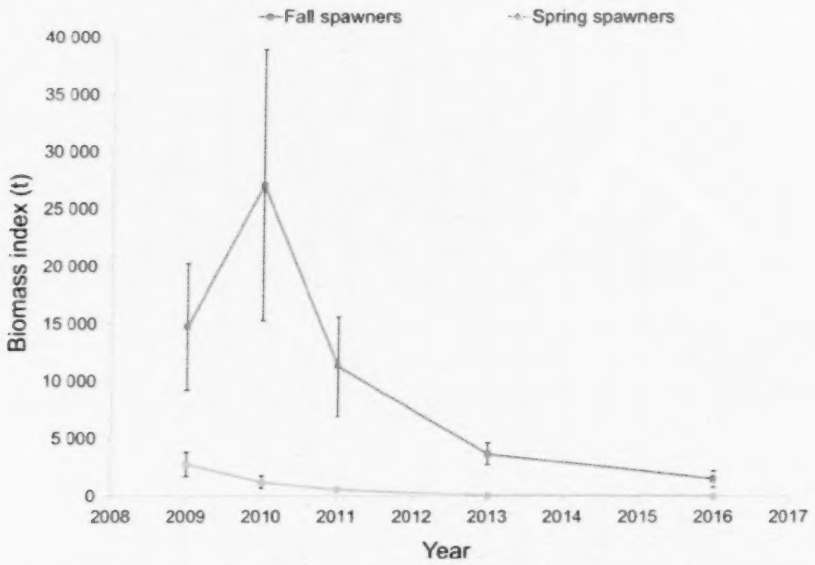

Figure 9. Biomass index (with standard error) of herring spawner stocks, spring (in green) and fall (in red), in unit area 4Sw located in the eastern part of the Lower North Shore of Quebec, as estimated by the acoustic surveys.

Sources of uncertainty

Due to the low number of spring spawners in the 2008–2016 biological samples, an accurate catch-at-age figure could not be calculated for this stock. This uncertainty makes it difficult to track cohorts of spring spawners during this period. There may also be incorrect age attribution when reading otoliths for fish aged 9 years and older, which can lead to errors and thus make it more difficult to track the cohorts.

Due to the time lag between the acoustic survey and the 2016 fishery, it was impossible to obtain samples to convert acoustic signals into biomass. To address this issue, commercial fishery samples were used. This affects the statistical independence of acoustic samples compared to fishery data and increases uncertainty in survey results.

According to industry representatives, juvenile herring concentrations are very close to coastlines. However, due to the rough seabeds and bathymetric map inaccuracies in certain 4S areas, the acoustic survey does not completely cover the area very close to shores. It is therefore possible that the acoustic survey sample of juvenile herring is inaccurate.

CONCLUSIONS AND ADVICE

Herring catches on Quebec's North Shore have increased significantly since the last assessment. Unlike the period prior to 2011 dominated by fixed gear fishery in the western part of the area, the majority of landings are now from the purse seine fishery concentrated mainly in the east end of unit area 4Sw.

The results of the acoustic surveys conducted in unit area 4Sw from 2009 to 2016 suggest the almost complete disappearance of spring-spawning herring as well as a sharp decrease in the abundance of fall-spawning herring. These two stocks consist mainly of fish aged 10 years and older.

Catches in recent years have been sustained primarily by the dominant 2005 year-class of fall spawners. Due to natural mortality and fishing, the abundance of this year-class will continue to decrease. Given the lack of significant recruitment, the older age of fish in catches and the decrease in the 4Sw biomass index, the current 4Sw catch level may lead to a local depletion of the resource. The fishing effort should be more dispersed all along the coast and less concentrated in 4Sw.

Moreover, the TAC of 4,000 t should not be increased given the total biomass index in 4S. If measures are not implemented to reduce fishing effort in 4Sw, the TAC should be reduced. Management measures should also be implemented to protect the spring spawning period.

For now, no analytical assessment has been conducted for the two herring spawner stocks on Quebec's North Shore. Once the new series of acoustic surveys for the entire 4S area is long enough, it will be possible to analytically assess both herring spawning groups, as well as establish limit reference points to define a strategic framework based on the precautionary approach for the fishery.

SOURCES OF INFORMATION

This science advisory report is from the April 12, 2017, meeting on the Assessment of the Quebec North Shore (4S) herring stocks in 2016. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

DFO. 2011. Assessment of the Quebec North Shore (Division 4S) herring stocks in 2010. DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2011/007.

DFO. 2015. Update of stock status indicators for Quebec North Shore (Division 4S) Herring in 2014. DFO Can. Sci. Advis. Sec. Sci. Resp. 2015/026.

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